Routledge
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Experimental Aging Research

An International Journal Devoted to the Scientific Study of the Aging Process

ISSN: 0361-073X (Print) 1096-4657 (Online) Journal homepage: www.tandfonline.com/journals/uear20

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To cite this article: Kylie O. Alberts, Isiah J. Espiritu & Alan D. Castel (02 Mar 2026): Spot the Scam: Identifying Email Scams and Scam Susceptibility in Younger and Older Adults, Experimental Aging Research, DOI: 10.1080/0361073X.2026.2635903

To link to this article: https://doi.org/10.1080/0361073X.2026.2635903

EXPERIMENTAL AGING RESEARCH
https://doi.org/10.1080/0361073X.2026.2635903

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Spot the Scam: Identifying Email Scams and Scam Susceptibility in Younger and Older Adults

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ABSTRACT

Background: Young and older adults are often victimized by various forms of scams and fraud. However, little research has been conducted on how a scam prevention intervention may impact young and older adults' accuracy and confidence in determining the legitimacy of emails. The present study investigated young and older adults' accuracy and confidence, as well as potential contributing factors to scam susceptibility, before and after engaging with one of three intervention activities: control (no intervention), read-only (read common scam qualities), or interactive (interactively learned scam qualities in emails).

Method: Young and older adult participants were randomly assigned to one of the three conditions. Before and after the intervention, participants evaluated a series of legitimate and scam emails, indicating whether each email was legitimate or a scam. Participants also rated their confidence in their accuracy, the personal relevance of each email, and their curiosity about engaging further with the email.

Results: Both age groups showed no difference in sensitivity when determining the legitimacy of the emails before and after the interventions. Importantly, both age groups in the read-only and interactive conditions showed a bias toward labeling emails as scams, indicating a generally cautious approach.

Conclusions: Although the interventions did not improve detection sensitivity, participants were more cautious when evaluating emails. This tendency may help reduce vulnerability to scams and fraud and suggests that interventions can encourage greater caution when evaluating suspicious emails across age groups.

ARTICLE HISTORY
Received 18 November 2025
Accepted 19 February 2026

Scams are becoming increasingly prevalent and detrimental to consumers, leading to emotional distress (DeLiema et al., 2021). In 2022 alone, the Federal Trade Commission (FTC) logged more than 2.4 million reports of fraud and consumers lost nearly $8.8 billion (Federal Trade Commission, 2023a). Older adults 70 years or older reported a median loss of $1,000, while young adults reported a median loss of $550 (AARP, 2023). Although these statistics encompass a broad spectrum of potential scams, the FTC reported that the most prevalent type of fraudulent activity involved imposter scams (Federal Trade Commission, 2023a), whereby a scammer pretends to be someone they are not. For example, a scammer may pretend to be the IRS or the Social Security Administration, or even pretend to be someone known to the victim (Federal Trade Commission, 2023a). Consumers of all ages can be affected by imposter scams as they target everyone. Older adults are perceived as

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being more susceptible to falling for scams because they are more likely to report losing money to scams (Federal Trade Commission, 2023a). However, the literature is generally mixed on whether older adults are more susceptible, if they are just more likely to report fraud. In some studies, older age has been found as a factor that could increase scam susceptibility (DeLiema et al., 2024; Whitty, 2019). Other studies have found that young and older adults are comparable in their ability to detect a scam (Robb & Wendel, 2023). Thus, despite some findings of older adults' high rates of scam susceptibility (Burnes et al., 2017), older adults may not be as disproportionately victimized as previously thought (Ross et al., 2014). The present study investigated older adults' scam susceptibility further through a scam susceptibility intervention for imposter scam e-mails. Accordingly, we investigated different factors that may contribute to scam susceptibility, such as personal relevance of a scam, curiosity, and loneliness. In addition, we examined young and older adults' confidence in determining the legitimacy of e-mails and how this may change after engaging with an intervention.

Many demographic factors may contribute to one's susceptibility to falling for a scam. People exhibiting one or more of several factors, such as old age, lower levels of cognitive function, lower levels of psychological well-being, poorer health, and poorer financial literacy, are the most susceptible to falling for scams (DaDalt, 2016; Ebner et al., 2023; James et al., 2014; Judges et al., 2017; Sur et al., 2023; Yu et al., 2023). In addition, one's trust in others influences their susceptibility to scams and could be a reason why older adults, in particular, may fall for scams, as they may be more trusting than young adults (Bailey & Leon, 2019; Shao et al., 2019). Studies have found that when rating faces on their trustworthiness, older adults are more likely to rate a face as trustworthy than young adults (Alberts et al., 2025; Castle et al., 2012). This could be because older adults may base their analysis of trustworthiness on familiarity, which may have the potential to increase scam susceptibility (Skurnik et al., 2005).

Scams generally capitalize on cognitive deficits present in all age groups, but that may be more prevalent in older adults. Young and older adults rely on schemas when recalling information from memory; however, relying on schemas often leads to errors in memory (Alba & Hasher, 1983; Brewer & Treyens, 1981). These errors can lead to gist-based false memories whereby the remembered information endorses information consistent with the theme of a prior event. Studies have found that people rely on gist-based information, or the main idea of information, when viewing advertisements, which causes them to miss verbatim, or detailed, information (e.g., Alberts & Castel, 2025; Brainerd & Reyna, 2004; Devitt & Schacter, 2016; Murphy et al., 2023). This could lead people to fall for scams because they are not attending to details that could be indicators that an e-mail is a scam. Therefore, people's lack of attention to detail may affect both young and older adults when viewing potential scams.

In addition, framing effects, or how information is presented, can also impact people's perceptions of the information they are viewing (Ebner et al., 2023; Kim, 2014; Tversky & Kahneman, 1981). Scams may be framed in a way that makes one want to engage with them. Older adults are also impacted by framing effects and show a positivity bias when associating items with gains and losses (Castel et al., 2016). With all these factors combined, older adults may perceive a "positive gist" from a scam due to how the scam is framed and decide to enroll in the scam.

Personal relevance and curiosity may also be correlated with scam susceptibility. Studies have shown that personal relevance is an important factor in the perception of advertisements by consumers (Campbell & Wright, 2008). Some studies have found that participants were more likely to believe computer virus warnings when they were more personally relevant (Bordia et al., 2005; Ebner et al., 2023). In other studies, perceived ad relevance seems to mitigate people's privacy concerns (Zhu & Chang, 2016). Therefore, if an e-mail is personally relevant to the consumer, they may be less likely to identify the e-mail as a scam. This may also be the case for e-mails that consumers are particularly curious about. Hargis et al. (2020) suggest that while curiosity can be seen as a protective factor for aging individuals (Swan & Carmelli, 1996), greater curiosity may create more opportunities for victimization from fraud. Trait curiosity, or an individual's general predisposition to seek knowledge, has been found to be a predictor of scam susceptibility (Moody et al., 2017). Curiosity may be detrimental because humans have an inherent desire to explore something they are curious about, also called the Pandora effect, whereby humans have a desire to resolve uncertainty even when the outcome may have negative consequences (Hsee & Ruan, 2016). Little research has investigated state curiosity, or the oscillation of curiosity depending on circumstances, in terms of scam susceptibility (Ma & Wei, 2023). Young and older adults may be more likely to engage with an advertisement or an e-mail that provides them with some "opportunity" for the individual that they would want to learn more about, without realizing that the "opportunity" is a scam (Yoon et al., 2009). Therefore, state curiosity may not be a protective factor when faced with a scam.

Due to the increasing number of people falling for scams, some type of intervention must be created to help young and older adults not fall for scams (Federal Trade Commission, 2025). While many cybersecurity trainings exist, few studies have specifically investigated interventions that can help the general public avoid falling for scams. Robb and Wendel (2023) found that when participants engaged in scam interventions varying from receiving general tips about scams to engaging with an experimental learning program, participants who interacted most closely with the scam and legitimate e-mails were significantly more accurate at correctly labeling e-mails as scams than those in a passive control group. Robb and Wendel (2022) also identified specific factors that seemed to predict scam susceptibility. For example, they found that, contrary to prior literature, susceptibility appears to decrease with age.

Little research has been conducted on young and older adults' confidence when engaging with scams, particularly before and after engaging with a scam intervention. Individuals across the lifespan are generally overconfident in their phishing e-mail detection (Wang et al., 2016). Canfield et al. (2019) found that when participants rated phishing e-mails on their legitimacy, participants were accurate in their confidence for legitimate e-mails but were overconfident in their detection of scam e-mails. Young and older adults are generally similarly well-calibrated in metacognitive judgments and memory performance, meaning that young and older adults can accurately assess their own performance (Alberts et al., 2025; Eakin et al., 2014; Hertzog & Dunlosky, 2011). The present study aims to investigate whether young and older adults will be calibrated in their scam detection performance before and after engaging with different interventions.

Current Study

The present study aimed to add to the scam intervention literature by using a paradigm modeled on Robb and Wendel (2023). Participants were randomly assigned into one of three groups: engaging in an interactive intervention (i.e., interactively learning scam qualities in real e-mails), a read-only intervention (i.e., reading about common scam qualities), or no intervention (control group). We predicted that more interaction with the intervention would result in participants being more accurate in identifying scam e-mails. Specifically, we anticipated that participants in the interactive intervention would be the best at identifying scams, followed by the read-only intervention group, and the control group, who should show little to no improvement in identifying scams. We explored participants' confidence in being able to detect a scam before and after the intervention, and whether this differs for young and older adults. In addition, we investigated whether young and older adults' confidence accurately distinguished between information with and without scams. We predicted that participants would be overconfident in their detection of scam e-mails and accurate in their ability to detect legitimate e-mails when they initially rated their confidence. We also predicted that, after the intervention, confidence ratings would increase for all types of e-mails, and participants would become more accurate in their confidence in their ability to detect legitimate and scam e-mails. Furthermore, we predicted that older adults' confidence levels would be similarly calibrated to young adults in their ability to detect scams and legitimate e-mails. Participants' confidence levels before and after the intervention could provide important insights on whether individuals are metacognitively aware of their ability to detect scams.

We predicted that if an e-mail scam is personally relevant to the individual, they will be less likely to detect the e-mail as a scam. When assessing state curiosity, we predicted that if one is curious to engage with an e-mail, they would be less accurate at detecting if the e-mail is a scam. We also explored different demographic features that may be correlated with one's performance in detecting scams and legitimate e-mails, such as loneliness, dementia-related anxiety, and prior scam susceptibility. Loneliness is generally correlated with worse scam detection accuracy; therefore, we predicted that there would be a correlation in the present experiment (Alves & Wilson, 2008; Chen & Schulz, 2016; DeLiema et al., 2023; Shao et al., 2019; Sur et al., 2021). In addition, dementia onset is found to be correlated with worse scam detection accuracy, suggesting that dementia-related anxiety would be correlated with higher scam susceptibility (Boyle et al., 2019). We also assessed one's sense of generativity, a concern for guiding the next generation, in relation to their ability to detect scams. Older adults generally express more generativity or have more concern for the next generation than young adults (McAdams et al., 1993). We hypothesized that older adults may be more willing to interact with information online despite potential errors in the information (e.g., spreading fake news, speaking to young adults reaching out), which could lead to heightened scam susceptibility (Barber & Mather, 2014; Brashier & Schacter, 2020) Lastly, we predicted that the higher participants scored on the scam susceptibility questionnaire, the less accurate they would be at determining the legitimacy of e-mails (DeLiema et al., 2025; James et al., 2014).

Method

Participants

One hundred six young adult participants (age range 18–34 years old; M_{age} = 20.47, SD = 2.17) were recruited through UCLA's undergraduate subject pool on SONA and participated online. One hundred eight older adult participants (age range 54–81 years old; M_{age} = 69.65, SD = 4.61) were recruited through Prolific and participated online. Young adults received course credit for participating in the study, with one hour of participation equaling one course credit granted. Older adults were compensated US $10 per hour. An a priori power analysis, using G*Power 3.1.7 (Faul et al., 2007), indicated that for a multiple regression analysis with twenty-six total predictors, assuming alpha = .05 and power = .80, 208 participants would be needed to reliably detect a medium effect size (n_p^2 = .06). Informed consent was acquired, and the study was completed in accordance with the UCLA Institutional Review Board. This study was not formally preregistered.

Materials & Procedure

Participants were randomly assigned to one of three groups: active interactive intervention, read-only intervention, or no intervention (control). Participants were not informed of their group assignment. Participants were asked how confident they were that they could correctly identify a scam on a scale of 0 (not at all confident) to 10 (very confident). Next, participants completed an e-mail judgment task, akin to that of Jones et al. (2019), whereby they viewed 24 e-mails (12 scams and 12 legitimate) and had to indicate which ones were legitimate. Each e-mail corresponded to one of three categories (finance, survey, or security) and were a mixture of personally received e-mails, select e-mails from Jones et al. (2019), and e-mails from websites showing examples of phishing e-mails ("*Phishing Attacks,*" n.d.; Fifty+ Phishing Email Examples, n.d.; Rafter, 2024; "Securing Labor Day," 2024; The most common examples of phishing emails, n.d.). See Figure 1 for example e-mails. All e-mails are available at https://osf.io/nu3xy/ on The Open Source Framework. Each e-mail was qualitatively different and was counterbalanced for each group. Participants were not informed how many of the e-mails would be scams or legitimate. After each e-mail, participants were asked how confident they were in their response. In addition, participants were asked how personally relevant the e-mails were to them on a scale of 0 (not relevant) to 10 (very relevant) and how curious they were to engage with the e-mail on a scale of 0 (not curious at all) to 10 (very curious).

Participants then engaged with their specific intervention depending on their assigned group. Participants in the interactive intervention were first told the common features of an imposter scam e-mail that would help them identify which e-mails are scams. These features included an incorrect e-mail address, misspellings in the e-mails, some form of urgency, an indication of wanting the person to click on a link or asking for sensitive information. After participants read these commonalities, they were asked to type the commonalities they had just learned about to ensure comprehension. Participants then engaged in an interactive intervention where they viewed three scam e-mails (each incorporating some of these features). Participants needed to correctly click on two parts of the e-mail that indicated a scam to move on to the next e-mail. Participants in the read-only intervention read the common features of an imposter scam, but did not have the interactive process whereby

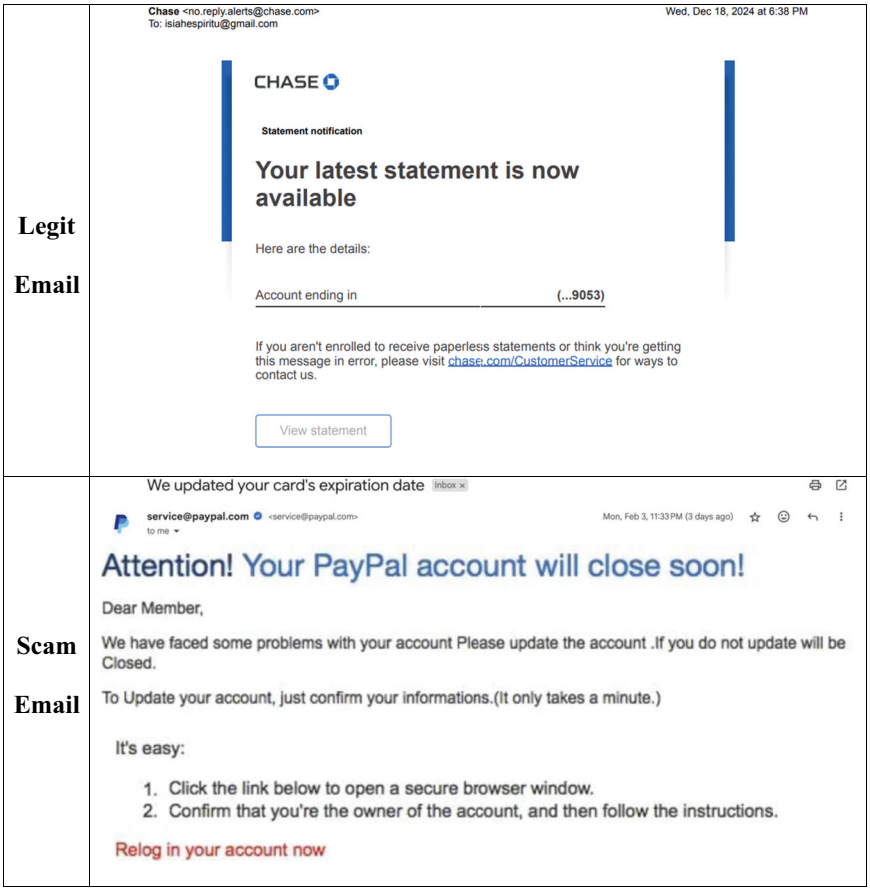

Figure 1. Example of a legitimate e-mail (top image) and a scam e-mail (bottom image) used in the present study.

they would click on the features of the e-mail. The control group was not told the common features of an imposter scam e-mail, and did not interact with finding parts of the e-mails that are scams. The read-only and control groups instead viewed the three scam e-mails and were asked to rate the e-mails on how personally relevant they were to them. It took all participants in the three groups a similar amount of time to complete their specific activity.

After the participants completed their specific task/intervention, all participants, once again, engaged in an e-mail judgment task where they viewed 24 new e-mails (12 legitimate, 12 scams) and had to indicate whether the e-mail was a scam or not. As in the first part of the study, participants were again asked about personal relevance, their confidence, and their curiosity level regarding the e-mails after viewing each e-mail.

After completing the scam detection task, all the participants completed the UCLA Loneliness Scale (Russell et al., 1980), which is a 20-item scale that assesses participants' general loneliness levels. An example of this scale is questions such as "How often do you feel happy?" and participants give a rating between one (meaning never happy) and four (meaning always happy). Participants also completed the Scam Susceptibility Questionnaire (James et al., 2014), which is a 5-item scale whereby participants rate their agreement to

different prompts about scams on a Likert scale. Participants' resulting score from the scale is generally correlated with how susceptible they would be to falling for a scam. An example statement from this scale would be a statement such as "I answer the phone whenever it rings, even if I do not know who is calling." Participants would respond with a rating from one (meaning strongly disagree) to seven (meaning strongly agree). Participants then completed the Modified Dementia Worry Scale (Roberts & Maxfield, 2021), which is a 12-item scale measuring dementia-related anxiety. In this scale, participants rated how typical each statement was to them on a scale of 1 (*not at all typical of me*) to 5 (*very typical of me*). An example question from the scale includes, "My worries about Alzheimer's disease and related dementias overwhelm me." Lastly, participants completed the Loyola Generativity Scale (McAdams & de St. Aubin, 1992), which is a 20-item scale whereby participants rate their agreement with different prompts assessing their sense of generativity on a scale of zero (never applies to me) to three (very often applies to me). An example statement from this scale would be a statement such as, "I feel as though I have made a difference to many people."

Results

Accuracy

Participants' probability of responding that an e-mail was a scam is shown in Figure 2. Participants' accuracy during the e-mail judgment task was analyzed by fitting a logistic mixed effects model using the *glmer* function using R Version 4.3.1 (R Core Team, 2021). More specifically, we analyzed how accurately participants were able to correctly identify a scam e-mail as a scam and a legitimate e-mail as legitimate. The model included a four-way interaction for Age (young vs. old) X Time (pre vs. post) X Condition (control vs. read-only vs. interactive) X E-mail Type (legitimate vs. scam). The model also included curiosity, personal relevance, and scam susceptibility questionnaire scores as predictors. Continuous predictors (confidence, curiosity, scam susceptibility, and personal relevance ratings) were standardized (z-scored) within participants before analysis to help facilitate interpretation. A likelihood ratio test indicated that including initial confidence did not significantly improve fit of the model, so we did not include it in our final model, $\chi^2(1) = 2.40$, $p = .12$. In addition, loneliness scores, $\chi^2(1) = .58$, $p = .44$, generativity scores, $\chi^2(1) = 2.64$, $p = .10$, and e-mail category (finance, survey, or security), $\chi^2(1) = .29$, $p = .86$, did not significantly improve the fit of the model. Therefore, we decided to proceed with a simpler model and did not include them in the final model. All variables were dummy coded with "older adults" as the comparison for age, "post" as the comparison for time, "control" as the comparison for condition, and "legitimate" as the comparison for e-mail type. We also included a random intercept for participants and e-mails. To test the simple effects of the model, we compared estimated marginal means of the full model using *emmeans* and *pairs* functions from Version 1.8.4 of the *emmeans* R package (Lenth, 2023). All data and analyses can be found on https://osf.io/nu3xy/ at The Open Source Framework.

The model revealed a significant effect of condition, such that the interactive group ($M = .64$, $SD = .48$), $b = .70$, $SE = .17$, $z = 4.13$, $p < .001$, and the read-only group ($M = .67$, $SD = .47$), $b = .48$, $SE = .17$, $z = 2.85$, $p = .004$, were estimated as having lower odds of correct responses compared to the control condition ($M = .66$, SD

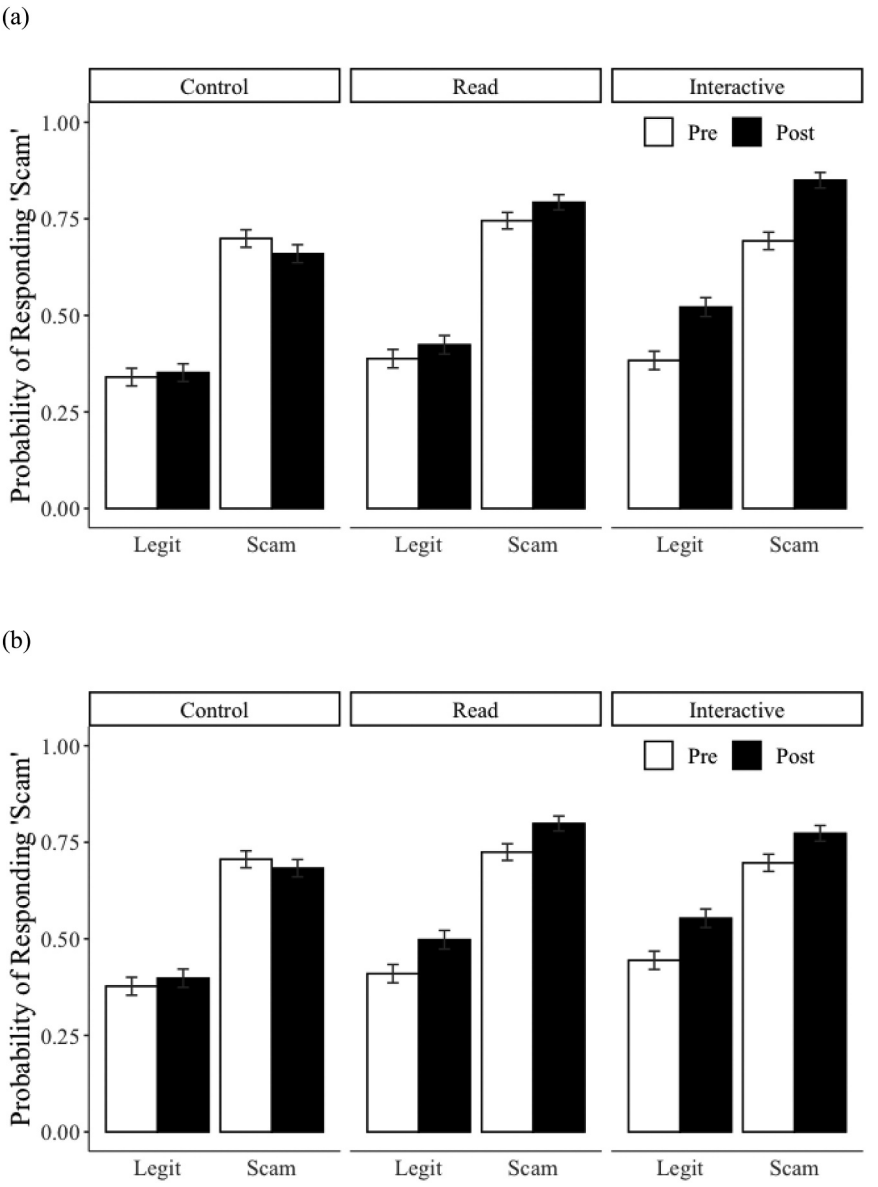

Figure 2. Young (a) and older (b) adults' probability of responding that an email was a scam in the email judgment task. Error bars reflect the standard error of the mean.

= .47). However, when we estimated marginal means, the results indicated that pairwise comparisons among the different condition groups were not statistically significant after adjusting for multiple comparisons. There was also no significant effect of time, $b = .11$, $SE = .15$, $z = .70$, $p = .48$, e-mail type, $b = .38$, $SE = .30$, $z = 1.28$, $p = .20$, nor state curiosity, $b = .04$, $SE = .04$, $z = 1.19$, $p = .23$. There was a significant effect of age: young adults ($M = .67$, $SD = .47$) were overall more accurate than older adults ($M = .64$, $SD = .48$), $b = .43$, $SE = .17$, $z = 2.47$, $p = .01$. Personal relevance for

each participant was operationalized on a rated scale of zero to ten. There was a significant effect of personal relevance, $b = .10$, $SE = .04$, $z = 2.89$, $p = .004$, whereby participants were more accurate at determining the e-mails' legitimacy when the e-mails were more personally relevant to them. The model also revealed a significant effect of scam susceptibility, $b = .06$, $SE = .01$, $z = 5.66$, $p < .001$, whereby the more susceptible the participants were, the less accurate they were.

Accuracy: Two-Way Interactions

The model revealed a significant two-way interaction between time and condition. However, when we estimated marginal means, the results indicated that pairwise comparisons among the different conditions and time groups were not statistically significant after adjusting for multiple comparisons. There was a significant two-way interaction between condition and e-mail type. The control group ($M = .64$, $SD = .48$) was more accurate at determining the legitimacy of legitimate e-mails than the interactive group ($M = .52$, $SD = .50$), $b = .56$, $SE = .09$, $z = 5.99$, $p < .001$, and the read-only group ($M = .57$, $SD = .50$), $b = .37$, $SE = .09$, $z = 3.97$, $p = .001$. However, the interactive group ($M = .75$, $SD = .43$), $b = .47$, $SE = .10$, $z = 4.75$, $p < .001$, and the read-only group ($M = .77$, $SD = .42$), $b = .49$, $SE = .10$, $z = 4.75$, $p < .001$, were more accurate at determining the legitimacy of scam e-mails than the control group ($M = .68$, $SD = .47$). There was no difference between the interactive and read-only groups for determining the legitimacy of legitimate, $b = .18$, $SE = .09$, $z = 2.04$, $p = .32$, or scam e-mails, $b = .02$, $SE = .10$, $z = .16$, $p = .10$. The control group had no difference in determining the legitimacy of scam or legitimate e-mails, $b = .18$, $SE = .26$, $z = .68$, $p = .98$. The interactive, $b = 1.21$, $SE = .26$, $z = 4.56$, $p < .001$, and read-only group, $b = 1.04$, $SE = .27$, $z = 3.91$, $p = .001$, were better at determining the legitimacy of scam e-mails than legitimate e-mails. The model also revealed a significant e-mail type by age group interaction. Young adults ($M = .60$, $SD = .49$) were more accurate at determining the legitimacy of legitimate e-mails than older adults ($M = .55$, $SD = .50$), $b = .3$, $SE = .08$, $z = 3.97$, $p < .001$. However, there was no difference in young ($M = .74$, $SD = .44$) and older adults' accuracy at determining the legitimacy of scam e-mails ($M = .73$, $SD = .44$), $b = .11$, $SE = .08$, $z = 1.35$, $p = .53$. Both young, $b = .71$, $SE = .26$, $z = 2.73$, $p = .03$, and older adults, $b = .91$, $SE = .26$, $z = 3.48$, $p = .003$, were more accurate at determining the legitimacy of scam than legitimate e-mails. The model did not indicate a significant time by age group interaction, nor a condition by age group interaction.

Accuracy: Three-Way Interaction

The model revealed a significant time by condition by e-mail type three-way interaction. Before participants engaged with the intervention, there was no difference in participants' accuracy in determining the legitimacy of legitimate e-mails for participants that were later placed in the control ($M = .65$, $SD = .48$) vs. the interactive group ($M = .59$, $SD = .49$), $b = .29$, $SE = .12$, $z = 2.39$, $p = .41$, the control vs. the read-only group ($M = .60$, $SD = .49$), $b = .25$, $SE = .12$, $z = 2.08$, $p = .64$, nor the read-only vs. the interactive group, $b = .04$, $SE = .12$, $z = .31$, $p = 1.00$. There was also no difference in participants' accuracy in determining the legitimacy of scam e-mails for participants that were later placed in the control ($M = .70$, $SD = .46$) vs. the interactive group ($M = .70$, $SD = .46$), $b = .003$, $SE = .13$, $z = .022$, $p = 1.00$, the control vs. the read-only group ($M = .74$, $SD = .44$), $b = .19$, $SE = .13$, $z = 1.36$, $p = .92$, nor

the read-only vs. the interactive group, $b = .20$, $SE = .13$, $z = 1.54$, $p = .93$. In addition, there was no difference between the control group participants' accuracy in determining the legitimacy of scam or legitimate e-mails, $b = .23$, $SE = .28$, $z = .84$, $p = 1.00$, read-only, $b = .69$, $SE = .28$, $z = 2.48$, $p = .35$, nor interactive group, $b = .53$, $SE = .28$, $z = 1.91$, $p = .75$.

After participants engaged with the intervention, participants in the control group ($M = .63$, $SD = .48$) were more accurate at determining the legitimacy of legitimate e-mails than those in the read-only ($M = .54$, $SD = .50$), $b = .49$, $SE = .12$, $z = 4.04$, $p = .003$, and interactive groups ($M = .46$, $SD = .50$), $b = .83$, $SE = .12$, $z = 6.86$, $p < .001$. However, participants in the interactive group ($M = .81$, $SD = .39$), $b = .94$, $SE = .14$, $z = 6.97$, $p < .001$, and the read-only group ($M = .80$, $SD = .40$), $b = .78$, $SE = .13$, $z = 5.90$, $p < .001$, were more accurate at determining the legitimacy of scam e-mails than the control group ($M = .67$, $SD = .47$). There was no difference between the read-only and interactive group in determining the legitimacy of legitimate e-mails, $b = .34$, $SE = .12$, $z = 2.86$, $p = .16$, nor scam e-mails, $b = .16$, $SE = .14$, $z = 1.15$, $p = .99$. There was no difference in the control groups' accuracy in determining the legitimacy of legitimate and scam e-mails, $b = .12$, $SE = .11$, $z = .62$, $p = 1.00$. However, the interactive, $b = 1.89$, $SE = .28$, $z = 6.76$, $p < .001$, and read-only groups, $b = 1.39$, $SE = .28$, $z = 4.98$, $p < .001$, were more accurate at determining the legitimacy of scam e-mails than legitimate e-mails.

The control group had no difference in accuracy for determining the legitimacy of legitimate, $b = .07$, $SE = .11$, $z = .62$, $p = 1.00$, and scam e-mails, $b = .18$, $SE = .11$, $z = 1.58$, $p = .92$, before and after the intervention. The read-only group also had no difference in the accuracy for determining the legitimacy of legitimate, $b = .30$, $SE = .11$, $z = 2.82$, $p = .17$, and scam e-mails, $b = .40$, $SE = .12$, $z = 3.22$, $p = .06$, although it neared significance. However, the interactive group was more accurate in determining the legitimacy of the legitimate e-mails before the intervention than after, $b = .61$, $SE = .11$, $z = 5.65$, $p < .001$. In addition, the interactive group was more accurate in determining the legitimacy of the scam e-mails after they engaged with the intervention, $b = .76$, $SE = .13$, $z = 6.06$, $p < .001$.

The model also revealed a significant condition by e-mail type by age three-way interaction. Older adults were significantly more accurate at determining the legitimacy of legitimate e-mails in the control group ($M = .61$, $SD = .49$) than those who were in the interactive group ($M = .50$, $SD = .74$), $b = .48$, $SE = .13$, $z = 3.69$, $p = .01$. There was no difference between the control and the read-only group ($M = .55$, $SD = .50$), $b = .32$, $SE = .13$, $z = 2.46$, $p = .37$, nor the interactive and read-only group, $b = .16$, $SE = .13$, $z = 1.24$, $p = .99$. Young adults were also more accurate at determining the legitimacy of legitimate e-mails in the control group ($M = .67$, $SD = .47$) than those that were in the interactive group ($M = .55$, $SD = .50$), $b = .64$, $SE = .13$, $z = 4.77$, $p < .001$. There was also no difference between the control and read-only group ($M = .59$, $SD = .49$), $b = .42$, $SE = .13$, $z = 3.14$, $p = .07$, nor the interactive and read-only group for young adults, $b = .22$, $SE = .13$, $z = 1.65$, $p = .89$.

Older adults showed no difference in the accuracy of determining the legitimacy of scams between the control group ($M = .69$, $SD = .46$) and the interactive group ($M = .74$, $SD = .44$), $b = .32$, $SE = .14$, $z = 2.29$, $p = .49$, the control group and the read-only group ($M = .76$, $SD = .43$), $b = .43$, $SE = .14$, $z = 3.05$, $p = .09$, nor the interactive group and the read-only group, $b = .11$, $SE = .14$, $z = .78$, $p = 1.00$. However, young adults were more accurate at determining the legitimacy of scam e-mails in the interactive group ($M = .77$, $SD = .42$), $b = .63$, $SE = .14$, $z = 4.38$, $p < .001$, and the read-only group ($M = .77$, $SD = .42$), $b = .55$, $SE = .14$, $z = 3.91$, p

= .005, than the control group (M = .67, SD = .47). There was no difference between the interactive group and the read-only group for young adults, b = .08, SE = .15, z = .52, p = 1.00.

Young adults, b = .03, SE = .28, z = .12, p = 1.00, and older adults, b = .39, SE = .28, z = 1.42, p = .96, in the control group showed no difference in accuracy for determining the legitimacy of scam and legitimate e-mails. Young adults in the control group also had no difference in their accuracy of determining the legitimacy of legitimate e-mails, b = .39, SE = .13, z = 2.91, p = .14, or scam e-mails, b = .03, SE = .14, z = .25, p = 1.00, from older adults in the control group. Young, b = .94, SE = .28, z = 3.37, p = .04, and older adults, b = 1.14, SE = .28, z = 4.10, p = .002, in the read-only group were both significantly more accurate at determining the legitimacy of scam e-mails than legitimate e-mails. Young adults in the read-only group also had no difference in their accuracy of determining the legitimacy of legitimate e-mails, b = .29, SE = .13, z = 2.21, p = .55, or scam e-mails, b = .09, SE = .15, z = .62, p = 1.00, from older adults in the read-only group. Young, b = 1.23, SE = .28, z = 4.41, p < .001, and older adults, b = 1.19, SE = .28, z = 4.30, p = .001, in the interactive group were both significantly more accurate at determining the legitimacy of scam e-mails compared to legitimate e-mails. Young adults in the interactive group also had no difference in their accuracy of determining the legitimacy of legitimate e-mails, b = .23, SE = .13, z = 1.78, p = .82, or scam e-mails, b = .28, SE = .15, z = 1.91, p = .76, from older adults in the interactive group. The model did not reveal a time by condition by age interaction.

Accuracy: Four-Way Interaction

The model also revealed a significant condition by e-mail type by age group by time interaction. Before engaging with an intervention, there was no difference in older adults' accuracy in determining the legitimacy of legitimate e-mails in participants that were later grouped in the control group (M = .62, SD = .49) compared to those in the interactive group (M = .56, SD = .50), b = .27, SE = .17, z = 1.58, p = 1.00, nor those in the read-only group (M = .59, SD = .49), b = .16, SE = .17, z = .96, p = 1.00. There was also no difference in accuracy for older adults in the interactive group and the read-only group, b = .10, SE = .17, z = .62, p = 1.00. There was also no difference in young adults' accuracy in determining the legitimacy of legitimate e-mails in the participants that were later grouped in the control group (M = .67, SD = .47) compared to those in the interactive group (M = .62, SD = .49), b = .31, SE = .17, z = 1.80, p = .98, nor those in the read-only group (M = .61, SD = .49), b = .34, SE = .17, z = 1.97, p = .95. There was also no difference in accuracy for young adults in the interactive group and the read-only group, b = .03, SE = .17, z = .18, p = 1.00. Before engaging with an intervention, there was also no difference in older adults' accuracy in determining the legitimacy of scam e-mails in the participants that were later grouped in the control group (M = .71, SD = .46) compared to those in the interactive group (M = .70, SD = .46), b = .12, SE = .18, z = .10, p = 1.00, nor those in the read-only group (M = .73, SD = .45), b = .12, SE = .18, z = .68, p = 1.00. There was no difference in accuracy for older adults in the interactive group and the read-only group, b = .10, SE = .18, z = .58, p = 1.00. There was no difference in young adults' accuracy in determining the legitimacy of scam e-mails in the participants that were later grouped in the control group (M = .69, SD = .46) compared to those in the interactive group (M = .69, SD = .46), b = .01, SE = .18, z = .07, p = 1.00, nor those in the read-only group (M = .75, SD = .44), b = .28, SE = .18, z = 1.51, p = 1.00. There was no

difference in accuracy for young adults in the interactive group and the read-only group, $b = .29$, $SE = .18$, $z = 1.59$, $p = 1.00$.

Before engaging with an intervention, there was also no difference in young, $b = .40$, $SE = .30$, $z = 1.35$, $p = 1.00$, and older adults, $b = .06$, $SE = .30$, $z = .21$, $p = 1.00$, who were later grouped into the control group's accuracy in determining the legitimacy of scam versus legitimate e-mails. There was also no difference in young, $b = .68$, $SE = .30$, $z = 2.28$, $p = .83$, and older adults, $b = .69$, $SE = .30$, $z = 2.30$, $p = .81$, who were later grouped into the read-only group's accuracy. In addition, there was no difference in young, $b = .36$, $SE = .30$, $z = 1.22$, $p = 1.00$, and older adults, $b = .69$, $SE = .30$, $z = 2.32$, $p = .80$, who were later grouped into the intervention group's accuracy. Comparing young and older adults, there was no difference in participants that were later grouped into the control groups' accuracy in determining the legitimacy of scam e-mails, $b = .01$, $SE = .18$, $z = .07$, $p = 1.00$, nor legitimate e-mails, $b = .35$, $SE = .17$, $z = 2.02$, $p = .94$. There was also no difference in young and older adults that were later grouped into the read-only groups' accuracy in determining the legitimacy of scam e-mails, $b = .17$, $SE = .18$, $z = .91$, $p = 1.00$, nor legitimate e-mails, $b = .17$, $SE = .17$, $z = 1.00$, $p = 1.00$. There was also no difference in young and older adults who were later grouped into the interactive groups' accuracy in determining the legitimacy of scam e-mails, $b = .02$, $SE = .18$, $z = .11$, $p = 1.00$, nor legitimate e-mails, $b = .30$, $SE = .17$, $z = 1.79$, $p = .98$.

After participants engaged with the intervention, older adults who were in the control group ($M = .60$, $SD = .49$) were more accurate at determining the legitimacy of legitimate e-mails than those in the interactive group ($M = .45$, $SD = .50$), $b = .70$, $SE = .17$, $z = 4.13$, $p = .008$. However, there was no significant difference between older adults who were in the control group and the read-only group ($M = .50$, $SD = .50$), $b = .48$, $SE = .17$, $z = 2.85$, $p = .40$, or between the read-only group and the interactive group, $b = .22$, $SE = .17$, $z = 1.30$, $p = 1.00$. In addition, young adults who were in the control group ($M = .67$, $SD = .47$) were more accurate at determining the legitimacy of legitimate e-mails than those in the interactive group ($M = .48$, $SD = .50$), $b = .96$, $SE = .17$, $z = 5.57$, $p < .001$. However, there was no significant difference between young adults who were in the control group and the read-only group ($M = .58$, $SD = .50$), $b = .50$, $SE = .17$, $z = 2.87$, $p = .38$, nor between the read-only group and the interactive group, $b = .46$, $SE = .17$, $z = 2.74$, $p = .48$. After participants engaged with the intervention, there was no difference between older adults who were in the control group's accuracy ($M = .68$, $SD = .47$) in determining the legitimacy of scam e-mails compared to the interactive group ($M = .77$, $SD = .42$), $b = .61$, $SE = .18$, $z = 3.35$, $p = .12$. There was also no difference between the control group and read-only group ($M = .80$, $SD = .40$), $b = .73$, $SE = .19$, $z = 3.92$, $p = .02$, nor in the interactive group and the read-only group, $b = .12$, $SE = .19$, $z = .61$, $p = 1.00$, for older adults. However, young adults who were in the read-only ($M = .79$, $SD = .41$), $b = 1.27$, $SE = .20$, $z = 6.41$, $p < .001$, and the interactive groups' accuracy ($M = .85$, $SD = .36$), $b = .82$, $SE = .19$, $z = 4.43$, $p = .002$, in determining the legitimacy of scam e-mails was higher than those in the control group ($M = .65$, $SD = .48$). There was no significant difference between young adults who were in the interactive group compared to those in the read-only group in determining the legitimacy of scams, $b = .45$, $SE = .21$, $z = 2.13$, $p = .90$.

After participants engaged with the intervention, there was no difference between young, $b = .13$, $SE = .30$, $z = .44$, $p = 1.00$, and older adults in the control groups' accuracy, $b = .38$, $SE = .30$, $z = 1.28$, $p = 1.00$, in determining the legitimacy of legitimate compared to scam

e-mails. However, both young, $b = 1.19$, $SE = .30$, $z = 3.93$, $p = .02$, and older adults, $b = 1.59$, $SE = .30$, $z = 5.25$, $p < .001$, in the read-only group were more accurate at determining the legitimacy of scam e-mails than legitimate e-mails. In addition, both young, $b = 2.10$, $SE = .31$, $z = 6.67$, $p < .001$, and older adults, $b = 1.69$, $SE = .30$, $z = 5.61$, $p < .001$, in the interactive group were more accurate at determining the legitimacy of scam e-mails than the legitimate e-mails.

After the participants in the control group engaged with the intervention, there was no difference between young and older adults' ability to determine the legitimacy of legitimate, $b = .43$, $SE = .17$, $z = 2.47$, $p = .70$, nor scam e-mails, $b = .08$, $SE = .17$, $z = .47$, $p = 1.00$. There was also no difference between young and older adults in the read-only groups' ability to determine the legitimacy of legitimate, $b = .41$, $SE = .17$, $z = 2.42$, $p = .74$, nor scam e-mails, $b = .01$, $SE = .20$, $z = .06$, $p = 1.00$. In addition, there was no difference between young and older adults in the interactive groups' accuracy in determining the legitimacy of legitimate, $b = .16$, $SE = .17$, $z = .95$, $p = 1.00$, nor scam e-mails, $b = .57$, $SE = .21$, $z = 2.80$, $p = .44$.

The model also revealed no difference between older adults in the control groups' accuracy in determining the legitimacy of legitimate e-mails before and after the intervention, $b = .11$, $SE = .15$, $z = .70$, $p = 1.00$. There was no difference between older adults in the control groups' accuracy in determining the legitimacy of scam e-mails before and after the intervention, $b = .13$, $SE = .16$, $z = .81$, $p = 1.00$. In addition, there was no difference between older adults in the read-only groups' accuracy in determining the legitimacy of legitimate e-mails before and after the intervention, $b = .42$, $SE = .15$, $z = 2.81$, $p = .43$. There was no difference between older adults in the read-only groups' accuracy in determining the legitimacy of scam e-mails before and after the intervention, $b = .48$, $SE = .17$, $z = 2.74$, $p = .48$. There was no difference between older adults in the interactive group's accuracy in determining the legitimacy of legitimate e-mails before and after the intervention, $b = .54$, $SE = .15$, $z = 3.56$, $p = .06$, although it neared significance. Lastly, there was no difference between older adults' accuracy in determining the legitimacy of scam e-mails before and after the intervention, $b = .46$, $SE = .17$, $z = 2.76$, $p = .47$.

The model revealed no difference between young adults in the control group's accuracy in determining the legitimacy of legitimate e-mails before and after the intervention, $b = .03$, $SE = .16$, $z = .19$, $p = 1.00$. There was also no difference between young adults in the control group's accuracy in determining the legitimacy of scam e-mails before and after the intervention, $b = .22$, $SE = .16$, $z = 1.42$, $p = 1.00$. In addition, there was no difference between young adults in the read-only group's accuracy in determining the legitimacy of legitimate e-mails, $b = .18$, $SE = .15$, $z = 1.20$, $p = 1.00$, and scam e-mails, $b = .32$, $SE = .18$, $z = 1.82$, $p = .98$, before and after the intervention. However, young adults in the interactive group were more accurate at determining the legitimacy of legitimate e-mails before the intervention than after, $b = .68$, $SE = .15$, $z = 4.43$, $p = .002$. Young adults in the interactive group were more accurate at determining the legitimacy of scam e-mails after engaging with the intervention than before, $b = 1.06$, $SE = .19$, $z = 5.69$, $p < .001$. In summary, the four-way interaction showed that young adults in the interactive group were the only group to show significant differences before and after engaging with the interventions. They showed higher accuracy in determining the legitimacy of scam e-mails and lower accuracy in determining the legitimacy of legitimate e-mails after engaging with the intervention.

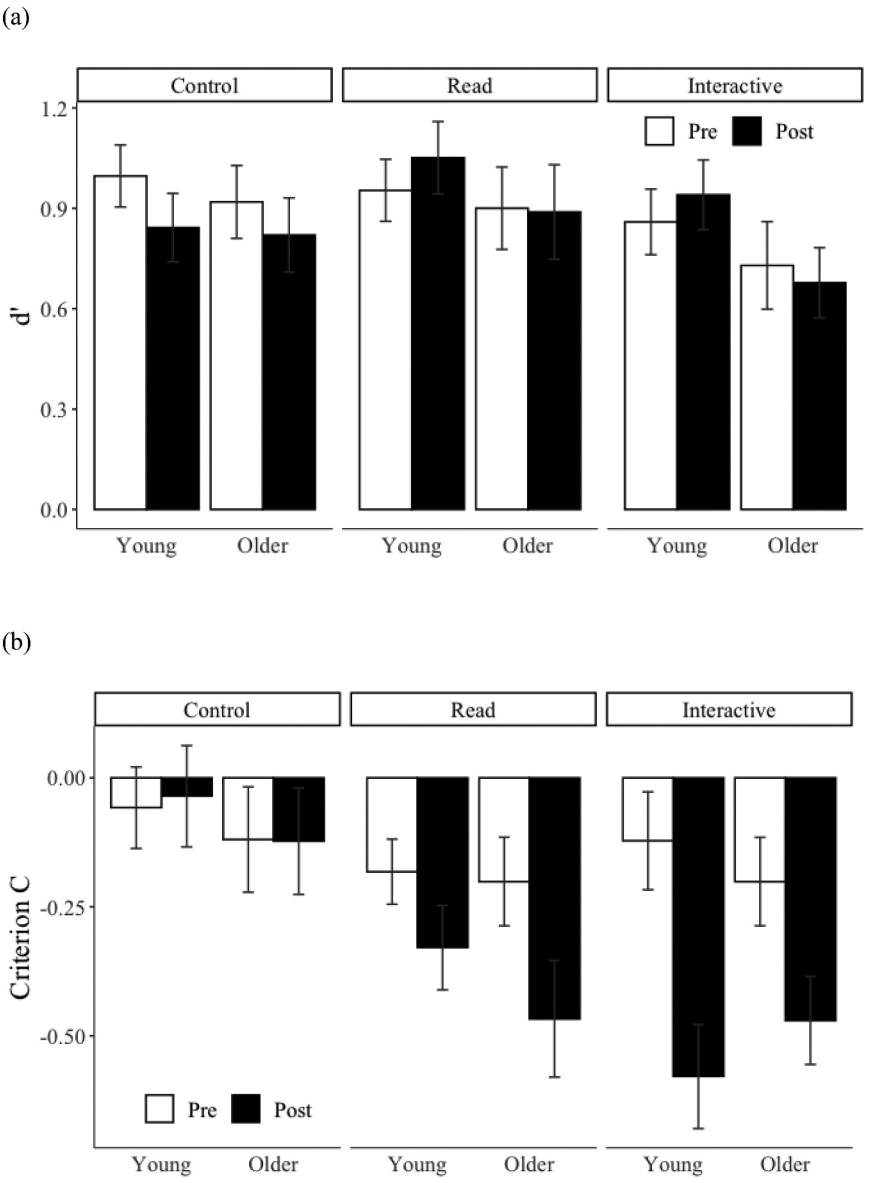

Figure 3. Sensitivity (a) and criterion (b) measures in the e-mail judgment task for young and older adults. Error bars reflect the standard error of the mean.

Sensitivity and Response Bias

To determine the sensitivity and bias to response that an e-mail was a scam, we employed a signal detection approach (Fraundorf et al., 2019; Wixted, 2007) to better understand how accuracy and changes in response criterion could be influenced by the interventions. Sensitivity (*d'*) and changes in response bias criterion (*c*) are shown in Figure 3 for each condition. Participants' sensitivity (*d'*) in determining the legitimacy of scam and legitimate e-mails during the e-mail judgment task was analyzed by fitting a linear mixed effects model

using the *lmer* function (Bates et al., 2015) in R (R Core Team, 2021). The model included a three-way interaction for Age (young vs. old) X Time (pre vs. post) X Condition (control vs. read-only vs. interaction). All variables were dummy coded with "older adults" as the comparison for age, "post" as the comparison for time, and "control" as the comparison for condition. We also included participants as a random intercept. In this study, a "hit" was denoted as participants correctly identifying a scam e-mail as a scam. A "false alarm" was when participants mistakenly identified a legitimate e-mail as a scam. The model revealed no main effect of condition. Thus, there was no difference between the interactive group and our dummy coded variable, the control group, $b = .14$, $SE = .16$, $t = .91$, $p = .36$, nor between the read-only group and the control group, $b = .07$, $SE = .16$, $t = .44$, $p = .66$. There was also no main effect of time, $b = .10$, $SE = .14$, $t = .72$, $p = .47$, nor a main effect of age, $b = .02$, $SE = .16$, $t = .14$, $p = .89$. There was also no condition by time, condition by age, time by age, nor a condition by time by age interaction. To corroborate our null results, we conducted a Bayes Factor comparing models with and without age group as an interaction term. We used BF_{01} because our inference statistics favored the null hypothesis (Kass & Raftery, 1995). The Bayes Factor yielded $BF_{01} > 100$, indicating strong evidence in favor of the null hypothesis that age group did not moderate effects of condition or time on d'. We also conducted a Bayes factor analysis comparing models with and without the age group term, which yielded $BF_{01} = 7.40$, indicating moderate evidence that *d'* did not differ reliably between age groups.

Participants' response bias (*c*) when determining the legitimacy of scam and legitimate e-mails was also analyzed by fitting a linear mixed effects model. If participants had more of a bias toward indicating an e-mail as a scam, they would be showing a liberal bias toward considering most e-mails to be a scam. If they had a bias toward indicating an e-mail as legitimate, then they would be showing a conservative bias toward considering most e-mails to be legitimate. The model included a three-way interaction for Age (young vs. old) X Time (pre vs. post) X Condition (control vs. read-only vs. interaction). All variables were dummy coded with "older adults" as the comparison for age, "post" as the comparison for time, and "control" as the comparison for condition. We also included participants as a random intercept. To test the simple effects of the model, we compared the estimated marginal means of the full model using *emmeans* and *pairs* functions from Version 1.8.4 of the *emmeans* R package (Lenth, 2023).

The model revealed a main effect of condition whereby there was more of a liberal bias, meaning that participants had a bias for indicating e-mails as a scam, for those in the interactive group ($M = -0.34$, $SD = .57$) than those in the control group ($M = -0.08$, $SD = .57$), $b = .26$, $SE = .08$, $t = 3.12$, $p = .006$. There was also more of a liberal bias for those in the read-only group ($M = -0.30$, $SD = .53$) than those in the control group, $b = .21$, $SE = .08$, $t = 2.54$, $p = .03$. There was no main effect of time, $b = .003$, $SE = .08$, $t = .04$, $p = .97$, nor a main effect of age, $b = .09$, $SE = .13$, $t = .67$, $p = .50$. The model revealed a condition by time two-way interaction. Before participants engaged with the intervention, there was no difference between the control ($M = -0.09$, $SD = .54$) and interactive group ($M = -0.16$, $SD = .54$), $b = .07$, $SE = .09$, $t = .79$, $p = .97$, the control and read-only group ($M = -0.19$, $SD = .45$), $b = .10$, $SE = .09$, $t = 1.12$, $p = .87$, nor the interactive and read-only group, $b = .03$, $SE = .09$, $t = .32$, $p = 1.00$. After participants engaged with the intervention, there was more of a liberal bias for those in the interactive group ($M = -0.52$, $SD = .56$) than those in the control group ($M = -0.08$, $SD = .60$), $b = .44$, $SE = .09$, $t = 4.85$, $p < .001$. There was also more

liberal bias in the read-only ($M = -0.40$, $SD = .59$) group than the control group, $b = .32$, $SE = .09$, $t = 3.47$, $p = .008$. There was no difference between the interactive group and the read-only group, $b = .13$, $SE = .09$, $t = 1.37$, $p = .74$. There was also no difference in the control group's bias before and after the intervention, $b = .01$, $SE = .06$, $t = .17$, $p = 1.00$. The read-only group had more of a liberal bias after the intervention than before, $b = .21$, $SE = .06$, $t = 3.72$, $p = .004$. The interactive group also had more of a liberal bias after the intervention than before, $b = .36$, $SE = .06$, $t = 6.53$, $p < .001$. There was no condition by age group, time by age group, nor a condition by time by age group interaction. To corroborate our null results, we conducted a Bayes factor analysis comparing models with and without age group as an interaction term, which yielded $BF_{01} > 100$, indicating strong evidence in favor of the null hypothesis that age group did not moderate effects of condition or time on response bias. We also conducted a Bayes factor analysis comparing models with and without the age group term, which yielded $BF_{01} = 10.40$, indicating strong evidence that response bias did not differ reliably between age groups. Results for response bias are shown in Figure 3.

Confidence

The confidence ratings provided by younger and older adults in each condition are shown in Figure 4. Participants' confidence in their responses of accurately indicating whether an e-mail was a scam or legitimate during the e-mail judgment task was analyzed by fitting a linear mixed effects model using the *lmer* function using R Version 4.3.1 (R Core Team, 2021). The model included a four-way interaction for Age (young vs. old) X Time (pre vs. post) X Condition (control vs. read-only vs. interactive) X E-mail Type (legitimate vs. scam). All variables were dummy coded with "older adults" as the comparison for age, "post" as the comparison for time, "control" as the comparison for condition, and "legitimate" as the comparison for e-mail type. We also included a random intercept for participants and e-mails. To test the simple effects of the model, we compared estimated marginal means of the full model using *emmeans* and *pairs* functions from Version 1.8.4 of the *emmeans* R package (Lenth, 2023).

The model revealed a significant effect of e-mail type, indicating that participants were more confident in their accuracy of determining the legitimacy of scam ($M = 7.38$, $SD = 2.13$) than legitimate e-mails ($M = 7.03$, $SD = 2.06$), $b = .42$, $SE = .16$, $t = 2.73$, $p = .007$. There was also a significant effect of age group, indicating that older adults ($M = 7.58$, $SD = 1.93$) were more confident in their accuracy of determining the legitimacy of the e-mails than young adults ($M = 6.82$, $SD = 2.19$), $b = .66$, $SE = .28$, $t = 2.32$, $p = .02$. There was no effect of time, $b = .06$, $SE = .12$, $t = .55$, $p = .58$. There was also no effect of condition, which indicated no difference between the interactive group and the control group, $b = .43$, $SE = .28$, $t = 1.53$, $p = .13$, nor the read-only group and the control group, $b = .14$, $SE = .28$, $t = .51$, $p = .61$.

Confidence: Two-Way Interaction

The model revealed a significant time by condition interaction. Before the intervention, there was no difference in confidence for participants who were later placed into the control group ($M = 7.09$, $SD = 2.04$) than with those who were later placed in the interactive group ($M = 7.25$, $SD = 2.16$), $b = .16$, $SE = .19$, $z = .84$, $p = .96$, nor with those placed in the read-only group ($M = 6.81$, $SD = 2.17$), $b = .28$, $SE = .19$, $z = 1.44$, $p = .70$.

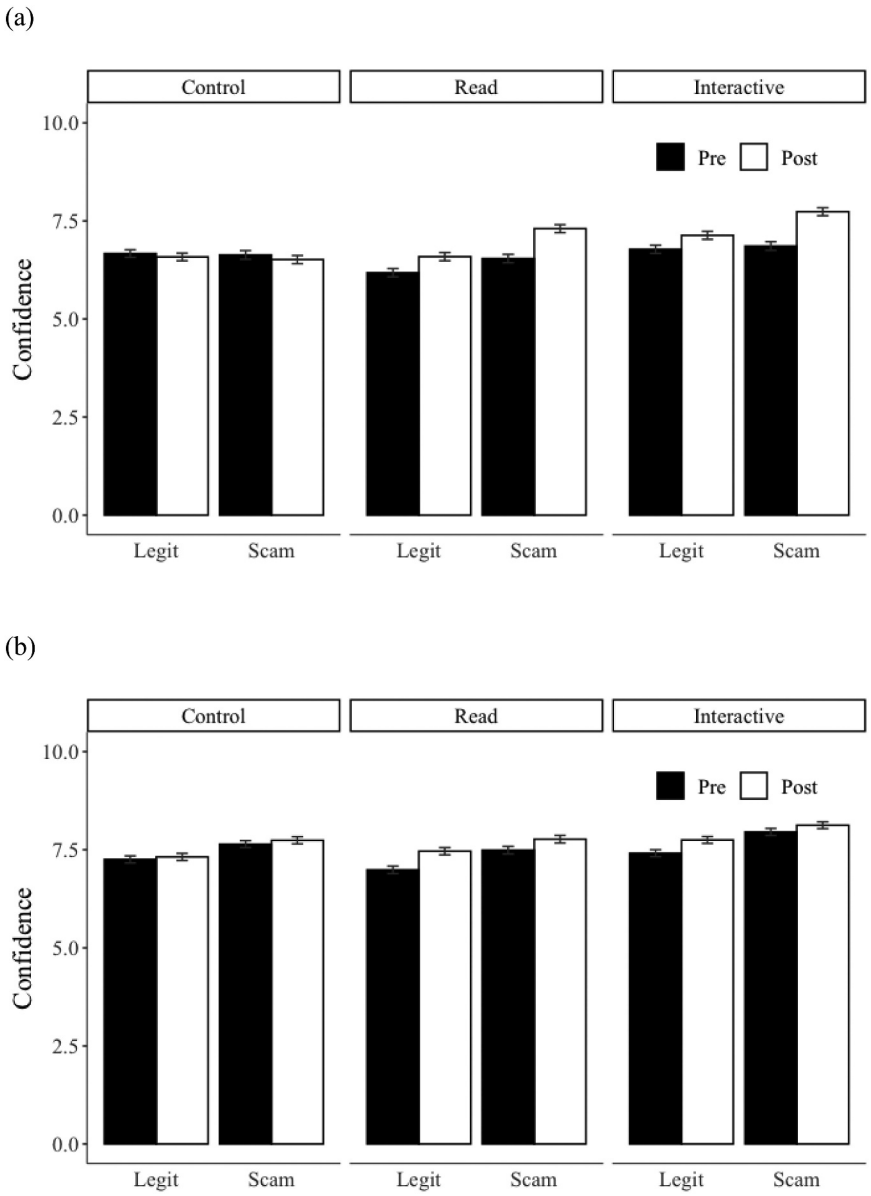

Figure 4. Young (a) and older (b) adults' confidence in their accuracy of determining the legitimacy of emails in the email judgment task before and after the interventions. Error bars reflect the standard error of the mean.

There was also no difference in participants who were later placed in the read-only group with those that were later placed in the interactive group, $b = .44$, $SE = .19$, $z = 2.27$, $p = .20$. After the intervention, however, participants in the interactive group ($M = 7.68$, $SD = 2.01$) were more confident in their accuracy than those who were in the control group ($M = 7.08$, $SD = 2.02$), $b = .60$, $SE = .19$, $z = 3.31$, $p = .02$. There was no difference between participants in the control and read-only group ($M = 7.30$, $SD =$

2.10), $b = .22$, $SE = .19$, $z = 1.13$, $p = .87$, nor between the participants in the interactive and the read-only group's confidence after they participated in the intervention, $b = .38$, $SE = .19$, $z = 1.99$, $p = .35$. The model also revealed that there was no difference in participants in the control group's confidence before and after engaging in the intervention, $b = .007$, $SE = .06$, $z = .11$, $p = 1.00$. However, participants in the read-only group were more confident in their accuracy after engaging in the intervention than before, $b = .49$, $SE = .06$, $z = 8.42$, $p < .001$. Participants in the interactive group were also more confident in their accuracy after engaging with the intervention than before, $b = .43$, $SE = .06$, $z = 7.47$, $p < .001$.

The model also revealed a significant e-mail type by age group two-way interaction. Older adults were more confident in their accuracy of determining the legitimacy of scams ($M = 7.79$, $SD = 1.92$) than legitimate e-mails ($M = 7.36$, $SD = 1.92$), $b = .42$, $SE = .11$, $z = 3.71$, $p = .001$. There was no difference in young adults' confidence in determining the legitimacy of legitimate ($M = 6.68$, $SD = 2.14$) and scam e-mails ($M = 6.96$, $SD = 2.24$), $b = .28$, $SE = .11$, $z = 2.42$, $p = .07$. Older adults were more confident in their accuracy for legitimate, $b = .68$, $SE = .16$, $z = 4.33$, $p < .001$, and scam e-mails, $b = .83$, $SE = .16$, $z = 5.26$, $p < .001$, than young adults. There was no significant time by e-mail type, condition by e-mail type, time by age, nor a condition by age two-way interaction.

Confidence: Three-Way Interaction

The model revealed a significant condition by e-mail type by age group three-way interaction. There was no difference between older adults in the control group ($M = 7.29$, $SD = 1.85$) and the interactive group ($M = 7.58$, $SD = 1.91$), $b = .29$, $SE = .27$, $z = 1.09$, $p = .99$, and between the control group and read-only group ($M = 7.22$, $SD = 1.99$), $b = .06$, $SE = .27$, $z = .23$, $p = 1.00$, in their confidence in determining the legitimacy of legitimate e-mails. There was also no difference between older adults in the read-only group and those in the interactive group, $b = .36$, $SE = .27$, $z = 1.32$, $p = 1.00$. The model also revealed that there was no difference between older adults in the control group ($M = 7.69$, $SD = 1.88$) and the interactive group ($M = 8.04$, $SD = 1.85$), $b = .35$, $SE = .27$, $z = 1.28$, $p = .98$, between the control group and the read-only group ($M = 7.63$, $SD = 2.01$), $b = .06$, $SE = .27$, $z = .23$, $p = 1.00$, and between the read-only and the interactive group, $b = .41$, $SE = .27$, $z = 1.51$, $p = 1.00$, in their confidence in determining the legitimacy of scam e-mails. In addition, there was no difference between young adults in the control group ($M = 6.69$, $SD = 1.99$) and the interactive group ($M = 6.94$, $SD = 2.18$), $b = .25$, $SE = .27$, $z = .92$, $p = 1.00$, between the control and read-only group ($M = 6.41$, $SD = 2.20$), $b = .29$, $SE = .27$, $z = .92$, $p = 1.00$, and between the read-only and the interactive group, $b = .54$, $SE = .27$, $z = 1.96$, $p = .72$, in their confidence in determining the legitimacy of legitimate e-mails. There was also no difference between young adults in the control ($M = 6.65$, $SD = 2.20$) and the interactive group ($M = 7.28$, $SD = 2.28$), $b = .63$, $SE = .27$, $z = 2.30$, $p = .47$, between the control and the read-only group ($M = 6.94$, $SD = 2.20$), $b = .30$, $SE = .27$, $z = 1.06$, $p = 1.00$, and between the read-only and the interactive group, $b = .34$, $SE = .27$, $z = 1.24$, $p = 1.00$, in their confidence in determining the legitimacy of scam e-mails.

The model revealed that there was no difference between older adults in the control group, $b = .41$, $SE = .13$, $z = 3.08$, $p = .09$, and read-only groups' confidence, $b = .41$, $SE = .13$, $z = 3.07$, $p = .09$, in determining the legitimacy of scam and legitimate e-mails. However,

older adults in the interactive group were more confident in determining the legitimacy of scam e-mails than legitimate e-mails, $b = .46$, $SE = .13$, $z = 3.47$, $p = .03$. There was also no difference between young adults in the control group, $b = .04$, $SE = .13$, $z = .32$, $p = 1.00$, and interactive groups' confidence, $b = .34$, $SE = .13$, $z = 2.55$, $p = .31$, in determining the legitimacy of scam and legitimate e-mails. However, young adults in the read-only group were more confident in determining the legitimacy of scam than legitimate e-mails, $b = .53$, $SE = .13$, $z = 4.03$, $p = .003$.

For participants in the control group, there was no difference between young and older adults' confidence in detecting legitimate e-mails, $b = .59$, $SE = .27$, $z = 2.17$, $p = .57$. However, older adults were more confident in determining the legitimacy of scam e-mails than young adults, $b = 1.04$, $SE = .27$, $z = 3.82$, $p = .007$. There was no difference between young and older adults in the read-only groups' confidence in detecting legitimate e-mails, $b = .82$, $SE = .27$, $z = 3.00$, $p = .11$, nor confidence in detecting scam e-mails, $b = .69$, $SE = .27$, $z = 2.52$, $p = .33$. There was also no difference between young and older adults in the interactive groups' confidence in detecting legitimate e-mails, $b = .64$, $SE = .27$, $z = 2.33$, $p = .45$, nor confidence in detecting scam e-mails, $b = .76$, $SE = .27$, $z = 2.78$, $p = .19$. The model revealed no significant time by condition by e-mail type, time by condition by age group, nor a time by e-mail type by age group three-way interaction.

Confidence: Four-Way Interaction

The model revealed a significant time by condition by e-mail type by age group four-way interaction. Before engaging with the intervention, there was no difference between older adults who were later grouped into the control group ($M = 7.25$, $SD = 1.85$) and those who were later grouped into the interactive groups' confidence ($M = 7.41$, $SD = 2.00$) in determining the legitimacy of legitimate e-mails, $b = .16$, $SE = .28$, $z = .55$, $p = 1.00$. There was also no difference between older adults who were later placed in the control group with those placed in the read-only group ($M = 6.99$, $SD = 2.03$), $b = .27$, $SE = .28$, $z = .94$, $p = 1.00$, nor between those in the read-only and interactive groups, $b = .42$, $SE = .28$, $z = 1.50$, $p = 1.00$. The model also revealed that there was no difference between older adults who were later grouped into the control group ($M = 7.64$, $SD = 1.86$) and those who were later grouped into the interactive groups' confidence ($M = 7.95$, $SD = 1.87$) in determining the legitimacy of scam e-mails, $b = .31$, $SE = .28$, $z = 1.10$, $p = 1.00$. There was also no difference between older adults who were later placed in the control group with those placed in the read-only group ($M = 7.49$, $SD = 2.01$), $b = .15$, $SE = .28$, $z = .54$, $p = 1.00$, nor between those in the read-only group and those in the interactive group, $b = .46$, $SE = .28$, $z = 1.64$, $p = 1.00$.

The model also revealed that, before engaging with the intervention, there was no difference between young adults' confidence in determining the legitimacy of legitimate e-mails who were later grouped into the control group ($M = 6.73$, $SD = 2.01$) and those who were grouped into the interactive group ($M = 6.77$, $SD = 2.21$), $b = .04$, $SE = .29$, $z = .15$, $p = 1.00$. In addition, there was no difference between young adults' confidence between the control and the read-only group ($M = 6.21$, $SD = 2.21$), $b = .52$, $SE = .29$, $z = 1.83$, $p = 1.00$, nor the interactive and read-only group, $b = .57$, $SE = .29$, $z = 1.97$, $p = .95$. There was also no difference between young adults who were later placed in the control group ($M = 6.71$, $SD = 2.28$) and those later placed in the interactive groups' confidence ($M = 6.84$, $SD = 2.32$) in determining the legitimacy of scam e-mails, $b = .14$, $SE = .29$, $z = .48$, $p = 1.00$. In addition,

there was no difference between young adults later placed in the control group and those in the read-only group ($M = 6.55$, $SD = 2.21$), $b = .16$, $SE = .29$, $z = .57$, $p = 1.00$, nor between those in the read-only and the interactive group, $b = .30$, $SE = .29$, $z = 1.10$, $p = 1.00$.

After participants engaged with the intervention, there was no difference between older adults in the control group ($M = 7.32$, $SD = 1.85$) and those in the interactive groups' confidence ($M = 7.75$, $SD = 1.80$) in determining the legitimacy of legitimate e-mails, $b = .43$, $SE = .28$, $z = 1.53$, $p = 1.00$. There was also no difference between older adults in the control group and read-only group ($M = 7.46$, $SD = 1.93$), $b = .14$, $SE = .28$, $z = .51$, $p = 1.00$, nor with those in the read-only and the interactive group, $b = .29$, $SE = .28$, $z = 1.02$, $p = 1.00$. In addition, there was no difference between older adults in the control group ($M = 7.74$, $SD = 1.90$) and those in the interactive groups' confidence ($M = 8.13$, $SD = 1.82$) in determining the legitimacy of scam e-mails, $b = .38$, $SE = .28$, $z = 1.36$, $p = 1.00$. There was also no difference between older adults in the control group and those in the read-only groups' confidence ($M = 7.77$, $SD = 2.00$), $b = .03$, $SE = .28$, $z = .10$, $p = 1.00$, nor between those in the read-only and those in the interactive group, $b = .36$, $SE = .28$, $z = 1.26$, $p = 1.00$.

The model also revealed that after participants engaged with the intervention, there was no difference between young adults in the control group ($M = 6.66$, $SD = 1.98$) and those in the interactive groups' confidence ($M = 7.12$, $SD = 2.14$) in determining the legitimacy of legitimate e-mails, $b = .46$, $SE = .29$, $z = 1.61$, $p = 1.00$. There was also no difference between young adults in the control group and the read-only group ($M = 6.61$, $SD = 2.14$), $b = .05$, $SE = .29$, $z = .17$, $p = 1.00$, nor between those in the read-only and the interactive group, $b = .51$, $SE = .29$, $z = 1.77$, $p = .99$. Young adults in the interactive group ($M = 7.72$, $SD = 2.15$) were significantly more confident in determining the legitimacy of scam e-mails than those in the control group ($M = 6.59$, $SD = 2.12$), $b = 1.13$, $SE = .29$, $z = 3.94$, $p = .02$. However, there was no difference between young adults in the control group and those in the read-only group ($M = 7.34$, $SD = 2.12$), $b = .75$, $SE = .29$, $z = 2.61$, $p = .59$, nor between those in the read-only and the interactive group, $b = .38$, $SE = .29$, $z = 1.33$, $p = 1.00$.

For participants in the control group, there was no difference between older adults' confidence in determining the legitimacy of legitimate e-mails before and after the intervention, $b = .06$, $SE = .12$, $z = .55$, $p = 1.00$. There was also no difference between older adults in the control groups' confidence in determining the legitimacy of scam e-mails before and after the intervention, $b = .10$, $SE = .12$, $z = .85$, $p = 1.00$. There was also no difference between young adults in the control groups' confidence in determining the legitimacy of legitimate, $b = .07$, $SE = .12$, $z = .62$, $p = 1.00$, or scam e-mails, $b = .12$, $SE = .12$, $z = .99$, $p = 1.00$, before and after the intervention. For participants in the read-only group, older adults were more confident in determining the legitimacy of legitimate e-mails after the intervention than before, $b = .47$, $SE = .12$, $z = 4.12$, $p = .008$. However, there was no difference between older adults in the read-only groups' confidence in determining the legitimacy of scam e-mails before and after the intervention, $b = .28$, $SE = .12$, $z = 2.44$, $p = .72$. There was no difference between young adults in the read-only groups' confidence in determining the legitimacy of legitimate e-mails before and after the intervention, $b = .40$, $SE = .12$, $z = 3.45$, $p = .09$. However, young adults in the read-only group were more confident in determining the legitimacy of scam e-mails after the intervention than before, $b = .80$, $SE = .12$, $z = 6.81$, $p < .001$. For participants in the interactive group, there was no difference between older adults' confidence in determining the legitimacy of legitimate e-mails before and after the

intervention, $b = .34$, $SE = .12$, $z = 2.95$, $p = .33$. In addition, there was no difference in older adults' confidence in determining the legitimacy of scam e-mails before and after the intervention, $b = .17$, $SE = .12$, $z = 1.49$, $p = 1.00$. There was also no difference between young adults in the interactive group's confidence in determining the legitimacy of legitimate e-mails before and after the intervention, $b = .35$, $SE = .12$, $z = 2.96$, $p = .32$. However, young adults in the interactive group were more confident in determining the legitimacy of scam e-mails after the intervention than before, $b = .88$, $SE = .12$, $z = 7.50$, $p < .001$.

Before engaging with the intervention, there was no difference between older adults who were later placed in the control group's confidence in determining the legitimacy of scam or legitimate e-mails, $b = .50$, $SE = .16$, $z = 3.24$, $p = .17$. There was also no difference between older adults who were later placed in the read-only group, nor those later placed in the interactive groups' confidence in determining the legitimacy of scam versus legitimate e-mails, $b = .54$, $SE = .16$, $z = 3.50$, $p = .08$. In addition, there was also no difference between young adults who were later placed in the control groups' confidence in determining the legitimacy of scam or legitimate e-mails, $b = .02$, $SE = .16$, $z = 1.13$, $p = 1.00$. There was also no difference between young adults who were later placed in the read-only group, $b = .34$, $SE = .16$, $z = 2.17$, $p = .89$, nor those later placed in the interactive groups' confidence in determining the legitimacy of scam versus legitimate e-mails, $b = .07$, $SE = .16$, $z = .47$, $p = 1.00$.

After engaging with the intervention, there was no difference between the older adults in the control group's confidence in determining the legitimacy of scam versus legitimate e-mails, $b = .42$, $SE = .16$, $z = 2.73$, $p = .49$. There was also no difference between older adults in the read-only group, $b = .31$, $SE = .16$, $z = 1.99$, $p = .95$, nor the interactive groups' confidence in determining the legitimacy of scam versus legitimate e-mails, $b = .38$, $SE = .16$, $z = 2.42$, $p = .74$. In addition, there was no difference between the young adults in the control group's confidence in determining the legitimacy of scam versus legitimate e-mails, $b = .06$, $SE = .16$, $z = .41$, $p = 1.00$. However, young adults in the read-only group were more confident in determining the legitimacy of scam than legitimate e-mails, $b = .73$, $SE = .16$, $z = 4.67$, $p < .001$. Young adults in the interactive group were also more confident in determining the legitimacy of scam than legitimate e-mails, $b = .60$, $SE = .16$, $z = 3.86$, $p = .02$.

Before the intervention, there was no difference between young and older adults who were later placed in the control groups' confidence in determining the legitimacy legitimate, $b = .52$, $SE = .28$, $z = 1.84$, $p = .98$, nor scam e-mails, $b = .94$, $SE = .28$, $z = 3.29$, $p = .15$. There was also no difference between young and older adults who were later placed in the read-only groups' confidence in determining the legitimacy of legitimate e-mails, $b = .78$, $SE = .28$, $z = 2.74$, $p = .48$, nor scam e-mails, $b = .94$, $SE = .28$, $z = 3.2$, $p = .13$. There was also no difference between young and older adults who were later place in the interactive groups' confidence in determining the legitimacy of legitimate e-mails, $b = .64$, $SE = .28$, $z = 2.25$, $p = .85$. However, older adults who were later placed into the interactive group were more confident in determining the legitimacy of scam e-mails than the young adults in the interactive group were, $b = 1.11$, $SE = .28$, $z = 3.89$, $p = .02$.

After participants engaged with the intervention, there was no difference between young and older adults in the control group's confidence in detecting legitimate e-mails, $b = .66$, $SE = .28$, $z = 2.32$, $p = .80$. However, older adults in the control group were more

confident in detecting scam e-mails than young adults in the control group, $b = 1.15$, $SE = .28$, $z = 4.03$, $p = .01$. There was no difference between young and older adults in the read-only groups' confidence in detecting legitimate, $b = .85$, $SE = .28$, $z = 3.00$, $p = .30$, nor scam e-mails, $b = .43$, $SE = .28$, $z = 1.51$, $p = 1.00$. There was also no difference in young and older adults in the interactive groups' confidence in determining the legitimacy of legitimate, $b = .63$, $SE = .28$, $z = 2.22$, $p = .86$, nor scam e-mails, $b = .40$, $SE = .28$, $z = 1.42$, $p = 1.00$.

Confidence and Accuracy

Participants' degree to which confidence predicted their accuracy during the e-mail judgment task, was analyzed by fitting a logistic mixed effects model using the *glmer* function using R Version 4.3.1 (R Core Team, 2021). The model had accuracy as the target variable and included a five-way interaction for Age (young vs. old) X Time (pre vs. post) X Condition (control vs. read-only vs. interactive) X E-mail Type (legitimate vs. scam) X Confidence (z score). All variables were dummy coded with "older adults" as the comparison for age, "post" as the comparison for time, "control" as the comparison for condition, and "legitimate" as the comparison for e-mail type. We also included a random intercept for participants and e-mails. To test the relationship between confidence and accuracy across different conditions, we compared estimated marginal trends of the full model using *emtrends* and *pairs* functions from Version 1.8.4 of the *emmeans* R package (Lenth, 2023).

The model revealed confidence did not predict participants' accuracy overall, $b = .20$, $SE = .13$, $z = 1.58$, $p = .11$. However, model revealed a significant condition by confidence interaction. The control group, $\beta = .31$, $SE = .05$, 95% CI [.22, .40], read-only group, $\beta = .21$, $SE = .05$, 95% CI [.12, .30], and the interactive group, $\beta = .21$, $SE = .05$, 95% CI [.12, .30], had significant positive associations between confidence and accuracy. However, when we estimated the pairwise comparison of slopes among the different condition groups was not statistically significant after adjusting for multiple comparisons. There was no significant time by confidence, age by confidence, nor an e-mail type by confidence interaction.

The model revealed a significant condition by time by confidence interaction. Before the interventions, the control group, $\beta = .31$, $SE = .06$, 95% CI [.18, .43], read only group, $\beta = .29$, $SE = .06$, 95% CI [.17, .41], and the interactive group, $\beta = .26$, $SE = .06$, 95% CI [.14, .38], had a significant positive association between confidence and accuracy. In addition, after the intervention, the control group, $\beta = .31$, $SE = .06$, 95% CI [.18, .44], and interactive group, $\beta = .17$, $SE = .07$, 95% CI [.03, .30], also had a significant positive association. After the read-only intervention, there was a positive association; however, it was not significant, $\beta = .12$, $SE = .06$, 95% CI [−.002, .25]. When estimating pairwise comparisons of slopes, we found that participants in the read-only group had a slightly stronger relationship between confidence and accuracy before the intervention than after, $b = .16$, $SE = .08$, $z = 1.95$, $p = .05$, which neared significance. There was no difference in the strength associations before and after the control group, $b = .004$, $SE = .09$, $z = .04$, $p = .97$, nor the interactive group, $b = .09$, $SE = .09$, $z = 1.10$, $p = .27$. Before the intervention, there was no difference between the control and the read-only group, $b = .02$, $SE = .09$, $z = .21$, $p = .98$, nor with the interactive group, $b = .05$, $SE = .09$, $z = .55$, $p = .85$. There was also no difference between the read-only group and the interactive group, $b = .03$, $SE = .08$, $z = .34$, $p = .94$. After the intervention

there was no difference between the control group with the read-only group, $b = .19$, $SE = .09$, $z = 2.07$, $p = .10$, and the interactive group, $b = .15$, $SE = .09$, $z = 1.57$, $p = .26$. There was also no difference between the read-only and interactive group, $b = .04$, $SE = .09$, $z = .45$, $p = .90$.

There was a significant condition by confidence by e-mail type interaction. The control group, $\beta = .27$, $SE = .06$, 95% *CI* [.14, .39], and read-only group, $\beta = .10$, $SE = .06$, 95% *CI* [−.01, .22], had a positive association between confidence and accuracy when determining the legitimacy of legit e-mails, although only the association for the control group was significant. The interactive group had a negative, non-significant, association between confidence and accuracy when determining the legitimacy of legit e-mails, $\beta = -.02$, $SE = .06$, 95% *CI* [−.13, .10]. The control group, $\beta = .35$, $SE = .06$, 95% *CI* [.23, .47], read-only group, $\beta = .31$, $SE = .06$, 95% *CI* [.18, .43], and the interactive group, $\beta = .44$, $SE = .07$, 95% *CI* [.31, .57], all had a significant positive association between confidence and accuracy when determining the legitimacy of scam e-mails. There was no difference in the strength of association between accuracy and confidence between scam and legit e-mails for the control group, $b = .08$, $SE = .09$, $z = .97$, $p = .33$, and the read-only groups, $b = .20$, $SE = .08$, $z = 2.42$, $p = .02$. However, confidence and accuracy were more strongly associated in the interactive group for scam than legit e-mails, $b = .46$, $SE = .09$, $z = 5.33$, $p < .001$. When determining the legitimacy of legit e-mails, there was a stronger association between confidence and accuracy for the control group than the interactive group, $b = .28$, $SE = .09$, $z = 3.22$, $p = .004$. There was no difference between the read-only group with the control group, $b = .16$, $SE = .09$, $z = 1.87$, $p = .15$, nor the interactive group, $b = .13$, $SE = .09$, $z = 1.43$, $p = .33$. When determining the legitimacy of scam e-mails, there was no difference in the strength of association for accuracy and confidence between the control group and read-only group, $b = .04$, $SE = .09$, $z = .48$, $p = .88$, nor with the interactive group, $b = .09$, $SE = .09$, $z = 1.00$, $p = .58$. There was also no difference between the read-only and the interactive group, $b = .13$, $SE = .09$, $z = 1.43$, $p = .33$.

The model also revealed an age group by e-mail type by confidence interaction. Young, $\beta = .22$, $SE = .05$, 95% *CI* [.13, .32], and older adults, $\beta = .01$, $SE = .05$, 95% *CI* [−.09, .12], had a positive association between accuracy and confidence when determining the legitimacy of legit e-mails, although the association was only significant for young adults. There was a significant positive association for both young, $\beta = .26$, $SE = .05$, 95% *CI* [.16, .35], and older adults, $\beta = .46$, $SE = .06$, 95% *CI* [.37, .59], when determining the legitimacy of scam e-mails. There was a stronger association between confidence and accuracy for older adults when determining the legitimacy of scam e-mails than legit e-mails, $b = .46$, $SE = .07$, $z = 6.39$, $p < .001$. But there was no difference for young adults, $b = .03$, $SE = .07$, $z = .48$, $p = .63$. There was a stronger association between accuracy and confidence for young adults than older adults when determining the legitimacy of legit e-mails, $b = .21$, $SE = .07$, $z = 2.98$, $p = .003$. However, there was a stronger association for older adults than young adults when determining the legitimacy of scam e-mails, $b = .22$, $SE = .07$, $z = 2.96$, $p = .003$.

Lastly, the model revealed a significant time by condition by e-mail type by confidence four-way interaction. Before the intervention, there was a significant positive association between accuracy and confidence for those in the control group when determining the legitimacy of legit, $\beta = .22$, $SE = .09$, 95% *CI* [.05, .39], and the scam e-mails, $\beta = .39$, $SE = .09$, 95% *CI* [.23, .56]. There was also a significant positive association in the read-only group when determining the legitimacy of legit, $\beta = .34$, $SE = .08$, 95% *CI* [.19, .50], and the scam

e-mails, $\beta = .23$, $SE = .09$, 95% CI [.06, .40]. In addition, there was a significant positive association for the interactive group when determining the legitimacy of legit, $\beta = .18$, $SE = .08$, 95% CI [.02, .33], and the scam e-mails, $\beta = .34$, $SE = .08$, 95% CI [.18, .51].

After the intervention, there was a significant positive association between accuracy and confidence for the control group when determining the legitimacy of legit e-mails, $\beta = .32$, $SE = .09$, 95% CI [.14, .49], and scam e-mails, $\beta = .31$, $SE = .09$, 95% CI [.14, .47]. There was also a significant positive association for the read-only group when determining the legitimacy of scams, $\beta = .38$, $SE = .09$, 95% CI [.20, .57]. There was a non-significant negative association for the read-only group when determining the legitimacy of legit e-mails, $\beta = -.14$, $SE = .08$, 95% CI [−.29, .02]. There was a significant positive association for the interactive group when determining the legitimacy of scams, $\beta = .54$, $SE = .10$, 95% CI [.34, .73]. But there was a significant negative association for the interactive group when determining the legitimacy of legit e-mails, $\beta = -.21$, $SE = .09$, 95% CI [−.37, −.04].

Before the intervention, there was no difference in the strength of the association between confidence and accuracy for those later placed in the control group and the read-only group, $b = -.13$, $SE = .12$, $z = 1.06$, $p = .90$, nor with the interactive group, $b = .04$, $SE = .12$, $z = .37$, $p = 1.00$, when determining the legitimacy of legit e-mails. There was also no difference between the those later placed in the read-only and the interactive group, $b = .17$, $SE = .11$, $z = -1.50$, $p = .67$. There was no difference between those later placed in the control group and the read-only group, $b = .16$, $SE = .12$, $z = 1.35$, $p = .76$, the control group and the interactive group, $b = .05$, $SE = .12$, $z = .43$, $p = 1.00$, nor the read-only and the interactive group, $b = .11$, $SE = .12$, $z = .93$, $p = .94$, when determining the legitimacy of scam e-mails. There was also no difference for those later placed in the control group, $b = .18$, $SE = .12$, $z = 1.47$, $p = .68$, the read-only group, $b = .11$, $SE = .11$, $z = .98$, $p = .93$, nor the interactive group, $b = .17$, $SE = .11$, $z = 1.48$, $p = .67$, when determining the legitimacy between scam and legit e-mails.

After the intervention, the association between confidence and accuracy was stronger for the control group than the read-only group, $b = .45$, $SE = .12$, $z = 3.71$, $p = .003$, and the interactive group, $b = .52$, $SE = .12$, $z = 4.21$, $p < .001$, when determining the legitimacy of legit e-mails. There was no difference between the read-only group and the interactive group, $b = -.07$, $SE = .12$, $z = .61$, $p = .99$. There was also no difference between the control and the read-only group, $b = .08$, $SE = .13$, $z = .61$, $p = .99$, the control group and the interactive group, $b = .23$, $SE = .13$, $z = 1.77$, $p = .49$, nor between the read-only and the interactive group, $b = .15$, $SE = .14$, $z = 1.12$, $p = .87$, when determining the legitimacy of scam e-mails. There was no difference in strength of association for the control group when determining the legitimacy of legit versus scam e-mails, $b = .01$, $SE = .12$, $z = .08$, $p = 1.00$. However, the interactive group, $b = .74$, $SE = .13$, $z = 5.83$, $p < .001$, and the read-only group, $b = .52$, $SE = .12$, $z = 4.26$, $p < .001$, had stronger associations in accuracy and confidence when determining the legitimacy of scam e-mails than legit e-mails.

When determining the legitimacy of legit e-mails, there was no difference in the strength of association between the control group and the read-only group, $b = .13$, $SE = .12$, $z = 1.06$, $p = .90$, the control group and the interactive group, $b = .04$, $SE = .12$, $z = .37$, $p = 1.00$, nor the read-only group and the interactive group, $b = .17$, $SE = .11$, $z = 1.50$, $p = .67$, before engaging with the intervention. However, after the intervention, the associations were stronger for the control group than the read-only,

$b = .45$, $SE = .12$, $z = 3.71$, $p = .003$, and the interactive group, $b = .52$, $SE = .12$, $z = 4.21$, $p < .001$, when determining the legitimacy of legit e-mails. There was no difference in the strength of association after the interactive intervention compared to after the read-only intervention, $b = .07$, $SE = .12$, $z = .61$, $p = .99$. There was no difference in strength between the control group before and after engaging with the intervention, $b = .10$, $SE = .12$, $z = .79$, $p = .97$. The read-only, $b = .48$, $SE = .11$, $z = 4.31$, $p < .001$, and the interactive groups, $b = .38$, $SE = .11$, $z = 3.39$, $p = .009$, had stronger associations before the intervention than after when determining the legitimacy of legit e-mails.

When determining the legitimacy of scam e-mails, there was no difference in the strength of association in accuracy and confidence between the control group and the read-only group, $b = .16$, $SE = .12$, $z = 1.35$, $p = .76$, the control group and the interactive group, $b = .05$, $SE = .12$, $z = .43$, $p = 1.00$, nor the read-only and the interactive group, $b = .11$, $SE = .12$, $z = .93$, $p = .94$, before engaging with the intervention. After engaging with the intervention, there was no difference in strength of association between the control and read-only group, $b = .08$, $SE = .13$, $z = -.61$, $p = .99$, the control and interactive group, $b = .23$, $SE = .13$, $z = 1.77$, $p = .49$, nor the read-only and the interactive group, $b = .15$, $SE = .14$, $z = 1.12$, $p = .87$. There was also no difference in strength of association before and after engaging with the control group, $b = .09$, $SE = .12$, $z = .76$, $p = .97$, the read-only group, $b = .15$, $SE = .13$, $z = 1.20$, $p = .83$, and the interactive intervention, $b = .19$, $SE = .12$, $z = 1.51$, $p = .66$, when determining the legitimacy of scam e-mails.

For participants in the control group, there was no difference in the strength of association between confidence and accuracy before and after engaging with the intervention when determining the legitimacy of legit e-mails, $b = .10$, $SE = .12$, $z = .79$, $p = .86$, and scam e-mails, $b = .09$, $SE = .12$, $z = .76$, $p = .87$. Before the intervention, there was also no difference in strength of association between scam and legit e-mails, $b = .18$, $SE = .12$, $z = 1.47$, $p = .45$. After the intervention, there was also no difference in the strength of association between scam and legit e-mails, $b = .01$, $SE = .12$, $z = .08$, $p = 1.00$.

For participants in the read-only group, there was a stronger association between confidence and accuracy before participants engaged with the intervention versus after, when determining the legitimacy of legit e-mails, $b = .48$, $SE = .11$, $z = 4.31$, $p < .001$. There was no difference in strength of association before participants engaged with the intervention and after when determining the legitimacy of scam e-mails, $b = .15$, $SE = .13$, $z = 1.20$, $p = .63$. Before the intervention, there was no difference in strength between legit and scam e-mails, $b = .11$, $SE = .12$, $z = .98$, $p = .76$. However, after the intervention, there was a stronger association when participants determined the legitimacy of scams than when they determined the legitimacy of legit e-mails, $b = .52$, $SE = .12$, $z = 4.26$, $p < .001$.

For participants in the intervention group, there was a stronger association between confidence and accuracy before participants engaged with the intervention versus after, $b = .38$, $SE = .11$, $z = 3.39$, $p = .004$, when determining the legitimacy of legit e-mails. There was no difference in strength of association before participants engaged with the intervention and after when determining the legitimacy of scam e-mails, $b = .19$, $SE = .13$, $z = 1.51$, $p = .43$. Before the intervention, there was no difference in strength between legit and scam e-mails, $b = .17$, $SE = .11$, $z = 1.48$, $p = .45$. After the intervention, there was a stronger association when participants determining the legitimacy of scam than when determining the legitimacy of legit e-mails, $b = .74$, $SE = .13$, $z = 5.83$, $p < .001$.

Discussion

The present study aimed to add to the scam intervention literature by having young and older adults engage in one of three intervention activities: control (no intervention), read-only (read common scam qualities), or interactive (interactively learned scam qualities in real e-mails), and investigating whether accuracy on an e-mail judgment task changes after engaging with the intervention. We initially predicted that both young and older adults would be more accurate at determining the legitimacy of e-mails after the interactive intervention than the read-only or the control group. We found that young adults were more accurate at determining the legitimacy of scam e-mails after the interactive intervention; however, they were less accurate at determining the legitimacy of legitimate e-mails. Older adults did not show any difference in accuracy before and after the intervention. When we investigated these findings further by examining participants' sensitivity and response bias using a signal detection approach (cf., Batailler et al., 2022; Fraundorf et al., 2019; Wixted, 2007), we found that both young and older adults did not differ in their sensitivity before and after engaging with any of the interventions. Therefore, participants did not really "improve" in their ability to determine the legitimacy of scam and legit e-mails after engaging with the interactive intervention. Instead, as shown by the response bias, participants were more likely to respond that the e-mails were a scam after engaging with the read-only and interactive interventions. These findings could indicate a very beneficial outcome in the real world. If interventions are making young and older adults more skeptical of e-mails when they could be a scam, this would likely decrease one's susceptibility to falling for scams, which is generally a recommended technique to avoid falling for scams (Federal Trade Commission, 2023b). Having a more liberal bias is very important when people need to identify a potentially dangerous piece of information. Akin to how a liberal bias is beneficial for Transport Security Administration (TSA) agents who are screening luggage for suspicious items in airports, missing a potentially dangerous item has much higher consequences than a "false alarm" (Biggs et al., 2013; Mitroff et al., 2018; Wolfe et al., 2013), as a false alarm in this context is only costly in terms of time to search additional bags, which is much less consequential than missing the detection of a harmful and dangerous item. So, in the case of e-mails, a "false alarm" in identifying a legitimate e-mail as a scam has much fewer consequences than engaging with an e-mail that is a scam and falling for it.

In the present study, the response bias seems to have led young adults in the interactive group to appear more accurate at identifying scam e-mails than before the intervention; however, this was not the case for the read-only group, despite the significant response bias we found. The interactive group findings are consistent with some prior literature (Kubilay et al., 2023; Robb & Wendel, 2023). Young adults who were in the read-only and the control group showed no difference in accuracy before and after engaging with the interventions in determining the legitimacy of legitimate and scam e-mails. Therefore, interventions for scams that involve just reading of study material may be ineffective for young adults, who are likely to quickly skip through company-required cybersecurity trainings and would not have a way to practice any learned material, and are not motivated to do so (Bada et al., 2019). Nevertheless, since young adults still showed a response bias in being more likely to respond that the e-mails were a scam after engaging with the read-only intervention, this

shows that the read-only intervention may make young adults more cautious in engaging with the e-mails (Kubilay et al., 2023).

When comparing young and older adults' responses by the different interventions, we did not find a difference between young and older adults' accuracy and sensitivity. Accordingly, these findings do not necessarily suggest that older adults are "worse" at determining the legitimacy of e-mails than young adults. Older adults just did not show the specific in-group accuracy improvement in determining the legitimacy of scam e-mails after the interactive intervention that young adults did. This finding may imply that the specific kinds of interventions that were implemented in this experiment may not be the most effective for teaching older adults how to avoid scam e-mails, especially given older adults' general mixed feelings about cybersecurity (Burke et al., 2022; Morrison et al., 2021). In addition, young adults may have had more experience with these trainings due to them closely emulating cybersecurity trainings that young adults would have likely had to engage with through companies or school. Therefore, a possible interpretation is that this experiment may have helped young adults further grasp already learned material, compared to older adults who were learning new information. Older adults may not have the potential to receive the same type of benefit that young adults had from prior training (Karpicke & Roediger, 2007, Storm et al., 2016; MacKay & Abrams, 1996; Meyer & Logan, 2013; van der Hoeven & de Bot, 2012). Although there were these specific differences in improvement through accuracy, potentially the most important takeaway from these interventions is that both young and older adults were more liberal in determining that e-mails were scams; therefore, they were more cautious when determining the legitimacy of e-mails after engaging with the interventions.

The present study also investigated participants' confidence in their ability to determine the legitimacy of e-mails. Consistent with our hypothesis and prior research, young adults were more confident in their accuracy for determining the legitimacy of scam e-mails after engaging with the interactive intervention (Kubilay et al., 2023). Yet, there was no difference in young adults' confidence in determining the legitimacy of legitimate e-mails, which is not entirely surprising given their lack of improvement in the accuracy of legitimate e-mails, and because of participants' bias toward determining that the e-mails were scams. Young adults were more confident in their accuracy for determining the legitimacy of scam e-mails after engaging with the read-only intervention, despite not actually improving their accuracy. Therefore, engaging with the read-only group may have given young adults a false sense of confidence after engaging with the intervention. This could also be due to participants recognizing that they became more cautious when viewing the e-mails after the interventions and were more likely to respond that the e-mails were scams. Young adults showed no difference in their confidence for determining the legitimacy of legitimate e-mails after engaging with the read-only intervention. Consistent with our hypotheses, there was no difference between young adults' confidence after engaging with the control intervention. However, older adults were not more confident in determining the legitimacy of e-mails after engaging with the interactive intervention, which does seem to deviate from the findings of young adults (Kubilay et al., 2023). This finding was reflective of older adults' accuracy performance in the interactive group. Older adults were more confident in their accuracy for determining the legitimacy of legitimate e-mails after engaging with the read-only intervention, which may indicate a false sense of confidence after reading about scam-related information for older adults. However, once again, this could be due to older adults

being aware that they had more of a bias toward indicating that the e-mails were a scam after the intervention, which may make older adults more confident in their ability to determine that an e-mail is a scam.

In terms of how confidence ratings mapped on to accuracy, participants' confidence in the read-only and the interactive group was less predictive of accuracy when determining the legitimacy of legitimate e-mails after they engaged with the interventions. This finding may imply that participants were unaware of their shown bias toward responding that the e-mails were scams, whether they were in fact scams or not. In addition, there was no difference between how much confidence predicted accuracy for any of the groups when determining the legitimacy of scam e-mails before and after engaging with the interventions. This finding seems to be in line with the sensitivity score results, where young and older adults seem to be more cautious when viewing the e-mails after the intervention, therefore leading them to be not as calibrated with their accuracy and confidence scores.

We also found that overall, young adults were more calibrated when determining the legitimacy of legitimate e-mails than older adults, and older adults were more calibrated than young adults when determining the legitimacy of scam e-mails. However, when these responses were broken up by time in the four-way interaction, there was no difference for age, which is consistent with prior research on confidence and aging (Alberts et al., 2025). Therefore, young and older adults seem to be receiving a similar benefit in confidence predicting their accuracy from the interactive intervention when determining the legitimacy of scam e-mails. Alternatively, this could be driven by participants knowing that they are being more cautious when viewing the e-mails because of the information they learned in the intervention. Accordingly, they are having a bias toward labeling the e-mails as being scams, and in turn are more confident in their scam responses. Future research should investigate this distinction to see what is driving participants' changes in confidence.

This study also specifically aimed to investigate different factors, such as scam susceptibility, curiosity, personal relevance, e-mail category, and confidence. Inconsistent with prior hypotheses, the more personally relevant the e-mails were to the participants, the more accurate participants were in determining the legitimacy of the e-mails (Campbell & Wright, 2008; Zhu & Chang, 2016). One potential explanation for this is that participants might be more knowledgeable about what legitimate e-mails that are more personally relevant to them look like, and since participants were expecting to see e-mails that could be scams, they may have been more on guard to evaluate personally relevant e-mails than in the real world. In terms of scam susceptibility, the more susceptible the participants were to scams, the less accurate they were at determining the legitimacy of the e-mails, which was consistent with prior research (James et al., 2014). Interestingly, there was no relationship between participants' curiosity in engaging with the e-mail further and participants' accuracy in determining the legitimacy of the e-mails. However, our experiment was only investigating state curiosity, and we did not include a trait curiosity measure. Therefore, trait curiosity may still be a predictor of accuracy on this task and should be investigated more (Litman & Spielberger, 2003; Moody et al., 2017; Tornblad et al., 2021). The model did not reveal a significant effect of loneliness or dementia-related anxiety. Prior intervention studies have found loneliness to be a significant predictor of scam susceptibility (Sur et al., 2021). Therefore, future research should investigate these potential predictors more because although they did not turn out to be

correlated with participants' accuracy in our experiment, they could still have implications for people in the real world when not being tested in an experimental setting (DeLiema et al., 2023). Lastly, as an exploratory analysis, we investigated whether young and older adults had differences in accuracy in determining the legitimacy of e-mails based on their e-mail category (finance, survey, or security). We found that the e-mail category was not predictive of participants' accuracy; therefore, if a legit or scam e-mail was a survey, for example, this did not impact participants' accuracy in determining the legitimacy of these e-mails. Future research should be conducted on young and older adults' accuracy in determining the legitimacy of more types of e-mails, as the Federal Trade Commission (FTC) has shown that young and older adults differ in the types of scams in which they report losing money (Federal Trade Commission, 2022).

One potential limitation of this study could be that young and older adults had differences in motivation and how participants were recruited for the study. In this study, young adults were given course credit for their participation and were recruited at UCLA and older adults were given monetary compensation and were recruited through Prolific. It is possible that motivation could impact performance in our study (cf., Greene & Naveh-Benjamin, 2022; Ryan & Campbell, 2021), and that the older adult are relatively high functioning and are interested in participating in research (and given they are participating on-line, this is a useful and relevant group to study for the interventions). In addition, we did not collect a wide age range of older adults' ages, leading to our not being able to break the older adult group into different age groups or examine age in a larger lifespan sample that includes middle-aged adults. Future research should focus on intentionally getting a wide range of adults so that the different age ranges within the older adult age group can be compared, which could lead to different results for how older adults engage with the intervention (Robb & Wendel, 2023). In addition, we did not collect measures for trait curiosity; therefore, our sample is lacking a baseline for participants' disposition to learn and seek out new knowledge (Moody et al., 2017; Whatley et al., 2025). Future may benefit by collecting measures for trait curiosity that can then be compared with state curiosity measures found in this study.

Considering the growing prevalence of scams and the increasing vulnerability of individuals to fall victim to them, it becomes imperative to conduct more comprehensive studies aimed at developing effective strategies for enhancing scam detection abilities (Prenzler, 2020). While certain job environments mandate cybersecurity training for their employees, this training is limited in scope and only reaches a fraction of those in need. This limitation is particularly concerning for older adults who have retired, as they often lack exposure to such training, making them prime targets for scammers (Nicholson et al., 2019). Additionally, even among younger adults who may have received some form of training, there appears to be a heightened susceptibility. Therefore, it is important to understand whether scam intervention training impacts both young and older adults, and more research should be conducted on this topic to best understand how to help people reduce scam susceptibility. The present study highlights the importance of interventions because young and older adults appeared to be more cautious of e-mails after engaging with the interventions and were more likely to label them as a scam, which in the real world could help reduce scam susceptibility in both age groups.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Funding

This research was supported in part by the National Institutes of Health National Institute on Aging; Award Number [R01 AG044335] to Alan D. Castel.

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